can be oriented with reference to the sides of the paraffine-receptacle or with reference to lines drawn upon the surface of the bottle.

When the cold water is allowed to enter in place of the warm, the paraffine congeals rapidly and may be easily removed as one piece. The discharge-pipe should open near the upper surface of the bottle, to draw off any air which may accumulate there.—*E. A. Andrews.*

Orientation of Small Objects for Section-Cutting.—It is frequently a very difficult matter to properly orient small objects, especially spherical eggs, so that sections may pass through any desired plane. In my work on the embryology of the common shrimp I have found the following process very convenient. Impregnation with paraffine is accomplished in the usual way, and then the eggs (in numbers) in melted paraffine are placed in a shallow watch-crystal. They immediately sink to the bottom, and then the whole is allowed to cool. The crystal, glass upwards, is now placed on the stage of the microscope and the eggs examined under a lens. In this way one can readily see exactly how any egg lies, and then with a knife it may be cut out with the surrounding paraffine, and in such a way that it can readily be fastened to the block in any desired position. After all which have dropped in a suitable position are thus cut out, the paraffine is again melted, and after stirring the eggs the cutting out is continued as before.—*J. S. Kingsley.*

PSYCHOLOGY.

The Perception of Space by Disparate Senses.—The following is an abstract of an interesting paper by Mr. Joseph Jastrow on the nature of space conceptions, contributed to *Mind*, vol. xi. p. 539. It records the result of experiments made on different persons at the Psychophysical Laboratory of the Johns Hopkins University, Baltimore:

In order to approach the problem by experimental methods it will be necessary to define accurately such terms as sight, touch, motion. The following classification, though provisional and imperfect, will perhaps be found convenient. We can obtain the notion of extension:

I. By the stimulation of a definite portion of a sensitive surface.

(1) Of the retina (where the distance of the stimulating object must be inferred);

(2) Of the skin,

(*a*) By the application of a pair of points, leaving the intermediate skin unstimulated, or (*a*) stimulating it by the application of a straight edge;

(*b*) By the motion of a point along the skin (see *Mind*, 40 pp. 557 ff.); [(*a*) and (*b*) may be contrasted as simultaneous and successive.]

II. By the perception of distance between two movable parts of the body, *e.g.* between thumb and forefinger;

III. By the free motion of a limb, *e.g.*, the arm.

The operations to be known as reproducing judgments by the eye, the hand, and the arm are respectively,—judging lengths by fixing the eyes upon them without motion of the eyeball, a form I; judging distances between thumb and forefinger, a form of II; and judging distances by guiding a pencil over them with a free arm movement, a form of III.

The problem was to compare the judgments of linear extension made by these three senses, and to determine their relative accuracy. The method consisted in presenting a definite length to one of these senses of the subject, who was then required to adjust a second length equal to the first by the use of the same or of another sense. The judgments were confined to lengths between 5 and 120 mm. The lower limit is set by the inconvenience of seeing, drawing, and measuring such small lines; the upper by the greatest "span" between thumb and forefinger, as well as by the longest line distinctly visible without motion of the eyeball. More direct methods of testing the relative fitness of these senses and of their memory for absolute lengths were also employed. In several of the operations the two sides of the body were involved, and it became necessary to study the effect of this circumstance.

RESULTS.

In judging that a length perceived only by the eye is equal to another length perceived either by the eye, hand, or arm, there will be an error. The problem consists in tracing the nature and extent of this error.

I. When the receiving and expressing senses are the same.

(1) If the eye is both receiving and expressing sense, small lengths will be underestimated, and large lengths exaggerated, the point at which no error is made being at about 38 mm.;

(2) If the hand is both receiving and expressing sense, small lengths will be exaggerated, and large lengths underestimated, the indifference point being at about 50 mm.;

(3) If the arm is both receiving and expressing sense, all lengths (within the limits of the experiments) will be exaggerated.

The conclusions above discussed may be summarized thus:

When the same acts as the receiving and the expressing sense, the error is small (and the process easy). In operations involving the use of both sides of the body, an interchange of the function of the two sides reverses the results; when one hand

alone is used in successive judgments, no such reversal takes place. The preferred hand in span-sensations is the right; the preferred arm in motion, the left. The error of the eye is less than that of the hand; the error of the hand slightly less than that of the arm.

II. When the receiving and expressing senses are different.

(1) If the eye is the expressing sense, and (*a*) the hand the receiving sense,

All lengths are greatly underestimated, the error decreasing as the length increases.

If the eye is the expressing sense, and (*b*) the arm the receiving sense,

All lengths are greatly underestimated, the error decreasing as the length increases. By combining the two conclusions we see that,—

If the eye is the expressing sense, all lengths are greatly underestimated, the error decreasing as the length increases.

(2) If the hand is the expressing sense, and (*a*) the eye the receiving sense,

All lengths are greatly exaggerated, the error decreasing as the length increases.

If the hand is the expressing sense, and (*b*) the arm the receiving sense,

All lengths are greatly exaggerated, the error decreasing as the length increases.

If the hand is the expressing sense, all lengths are greatly exaggerated, the error decreasing as the length increases.

(3) If the arm is the expressing sense, and (*a*) the eye the receiving sense,

All lengths are greatly exaggerated, the error decreasing as the length increases.

If the arm is the expressing sense, and (*b*) the hand the receiving sense,

All lengths are greatly underestimated, the error decreasing as the length increases.

A. The error decreases as the length (to be reproduced) increases.

This means that (within the limits of the lengths experimented upon) a larger length is reproduced more accurately than a smaller one.

B. If reproducing one sense by another results in an exaggeration (or underestimation), then reproducing the second sense by the first will result in an underestimation (or exaggeration) to about the same extent.

C. A third rather peculiar law remains to be noticed. The processes involved in the above-described experiments can be represented thus: A length presented to the receiving sense makes a certain impression on my brain-centre; the problem,

then, is to reproduce the objective stimulation, which shall give me an equivalent sensation. The two operations being simultaneous, the sensations can be compared and the judgments corrected until they agree. When the receiving and expressing senses are the same, the comparison is between homogeneous sensations, involving one brain-centre; the operation is easy and the error small. When the expressing sense differs from the receiving sense, heterogeneous sensations must be compared, involving two brain-centres,—a difficult operation with a large error. The large error seems to be due to a looseness of association between heterogeneous space-centres; it is a path of high resistance. Why this error is in the direction in which it is, and not in the opposite direction, depends on some fundamental relation of the senses involved, still to be discovered. For the present the fact that the same objective spacial stimulation has a different value for the several space-senses is to be emphasized. Our conclusions, then, are (1) that the memory for absolute measurements is not quite accurate, the order of accuracy being sight, span, motion; (2) that the operation probably consists in matching the reproduction with the homogeneous mental recollection; (3) that the visual inch is too short, the span- and motion-inch too long. These conclusions evidently favor the point of view of law C.

D. Finally, a comparison of the error in reproducing by the same and by a different sense leads to the very important conclusion that the former operation is an accurate and easy one, the latter an inaccurate and difficult one. The difficulty manifests itself as a feeling of discomforting uncertainty and lack of confidence in one's judgments, and a great susceptibility of fatigue. The connection between senses seems to be a loose one.

SCIENTIFIC NEWS.

— Engelmann, of Leipzig, announces a continuation of the well-known Bibliotheca Zoologica of Carus and Engelmann, bringing the work down to 1880. The former work contained a catalogue of the literature of zoology from 1846 to 1860, and was itself a continuation of Agassiz's Bibliographia Zoologiæ et Geologiæ, which contained the works previous to the earlier date. The establishment of the *Zoologischer Anzeiger* in 1878 furnished a regular record for zoological literature, and hence this continuation of the Bibliotheca fills in the gap between the *Anzeiger* and the Bibliotheca of Carus and Engelmann, and thus places in the hands of zoologists a complete list of works on zoology. This continuation will be edited by Dr. Taschenberg, of Halle,